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METHYL BROMIDE SOIL FUMIGATION PROCEDURES IN GREENHOUSES

HAZARDOUS CONTAMINANTS COORDINATION BRANCH
ONTARIO MINISTRY OF THE ENVIRONMENT
OCTOBER 1986

This publication has been reviewed by the Ontario Pesticides Advisory Committee.

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PHYSICAL PROPERTIES OF METHYL BROMIDE

Common Name	Methyl Bromide (monobromomethane)
Formula	CH_3Br
Commercial Grades	Not less than 99.5% pure.
Physical State	Gas at normal temperature and pressure. Liquid under pressure in cylinders or cans at normal temperature.
Flash Point	Practically nonflammable. Has been used as a fire extinguisher.
Boiling Point	3.6°C (38.5°F) at normal pressure.
Colour	Colourless.
Reaction with Metals	Not particularly corrosive to most metals. However, the liquid will react with aluminum, magnesium, and their alloys, possibly with ignition.
Odour	Odourless at fumigation concentrations.
Solubility	Slightly soluble in water (1.34 g/100 ml at 25°C and 760 mm Hg).
Specific Gravity of Gas (Air = 1)	3.27 at 0°C
Threshold Limit Value (Inhalation)	5 ppm by volume (20 mg/m^3) (ACGIH - 1985)

HAZARDS

Health Concerns

Methyl bromide is a very toxic chemical. Oral intake, vapour inhalation, or prolonged or repeated contact with the skin is harmful. Liquid contact with skin or mucous membranes can cause severe burns. Exposure to high concentrations of vapour may cause delayed skin burns. Vapour inhalation will cause lung irritation, varying from mild bronchitis to respiratory failure. The respiratory effects are usually accompanied, or followed, by effects on the central nervous system. The vapour has no appreciable odour in low concentrations. Concentrations above 1000 ppm have a sweet chloroform-like odour. However, odour is not a reliable warning property.

The threshold limit value suggested by the American Conference of Governmental Industrial Hygienists (ACGIH) is 5 ppm in air by volume. (Time-weighted average exposure which is safe for repeated daily exposures of 8 hours duration).

Acute Toxicity

Repeated exposures to 100 ppm, 7 hours a day, can produce very serious poisoning. Single exposures to 1000 ppm for 30 to 60 minutes are very dangerous to life. The effects are on both the respiratory and the central nervous systems. Unless the concentration is high enough to cause rapid narcosis and death from respiratory failure, the most striking response to exposure at high concentrations is lung irritation resulting in congestion and oedema. Pulmonary effects may be somewhat delayed and bronchial pneumonia often develops later. Symptoms may also include nausea and vomiting, cough, chest pain and shortness of

Central nervous system effects usually accompany, or follow by several hours, the respiratory symptoms. Individuals exposed to lower concentrations may show only central nervous system effects. Their symptoms would include nausea and vomiting, dizziness, blurred vision, staggering gait and slurred speech. Convulsions are a common symptom.

At the first sign of any of the above symptoms, the affected person and his assistants should immediately get out of the fumigation area and into fresh air. Under some circumstances, symptoms may not show up until 48 hours after exposure.

The patient should be kept warm and the doctor called immediately. If the patient stops breathing, administer artificial respiration until a doctor arrives and takes charge. There is no antidote. The booklet containing procedures for "First Aid and Treatment for Methyl Bromide Exposure" should be given to the doctor who takes charge of the patient. This booklet is available at your local dealer, Dow Chemical Company, or Great Lakes Chemical Corporation.

First Aid

In case of accident, call a physician immediately. If there has been liquid contact with skin or clothing, remove all clothing and wash the skin with plenty of soap and water. If splashed into the eyes, flush the eyes with water for at least 15 minutes. If inhaled, place the patient in fresh air, face downward with head slightly below level of lungs. The patient should be kept warm. If the patient stops breathing administer artificial respiration until a doctor arrives and takes charge.

Chronic Toxicity

Exposure to low, but harmful, concentrations of methyl bromide over a long period of time, results in a variety of signs and symptoms, most of which are due to injury to the central nervous system. In order of frequency, these are: visual disturbances, slurred speech, numbness of the extremities, mental confusion, hallucinations, tremor and frequent fainting attacks. Symptoms may subside within a few days after termination of exposure, or may persist for several months. Numbness of the extremities and visual disturbances are the last to subside. Complete recovery is the rule.

Eyes

Direct contact of the eyes or eyelids to liquid methyl bromide may cause serious injury to either or both.

Skin

Since methyl bromide has a very low boiling point, it evaporates from the surface of the skin rapidly causing tingling, burning and numbness, followed by aching pain. However, if the material is spilled on clothing, gloves, or shoes, such coverings may maintain close and continuous contact of the methyl bromide with the skin. Since there is often no particular sensation produced by such contact, the individual may be unaware that the exposure has occurred, and burns may result. Blisters commonly appear after several hours. If exposure is not sufficient to cause blisters, itching dermatitis may appear after several days. Rubber gloves, jewellery, cigarettes, wallets, etc. should not be worn or carried when in an atmosphere containing methyl bromide.

METHYL BROMIDE AS A FUMIGANT

Methyl bromide is a very efficient soil fumigant when handled and used according to label directions and accepted fumigation practices.

It has demonstrated its effectiveness on many species of insects, weed seeds, damping-off organisms and nematodes. It kills insects in all stages of their life cycles through the spiracles of the respiratory system. Specialized respiratory channels or diffusion allows the fumigant to penetrate the egg. Since an increase in ambient temperature increases the rate at which an insect respires, it becomes more susceptible to the fumigant as the temperature rises.

Methyl bromide has the ability to penetrate soil, mulch and compost quite readily and achieve a complete kill within 24 hours. Because temperature and other environmental conditions affect the dosage required to achieve a complete kill, the exposure may need to be lengthened under certain circumstances, e.g. high moisture content.

Methyl bromide is only one of several fumigants that can be used for soil sterilization in a greenhouse. The methods outlined below are effective and efficient provided that the fumigator has all the equipment necessary and follows the procedures in proper sequence. Since methyl bromide is odourless, chloropicrin is used as a warning gas, a formulation of 98% methyl bromide with 2% chloropicrin is normally used. Because chloropicrin is phytotoxic, methyl bromide containing this gas as a warning agent should not be used on living plants.

In both methods A and B below, soil can be fumigated either in flats stacked in a pile or the beds themselves can be fumigated directly on the ground. The soil should be loose, not compacted, and at a temperature above 10°C at the 10 cm depth level. Best results are obtained when soil temperature is above 16°C at the 10 cm depth level. Double the exposure time if the soil temperature is between 10°C and 16°C.

METHOD A

Equipment Needed

1. Polyethylene tarp or similar plastic tarp large enough to cover the flats or bed with a few centimetres extra.

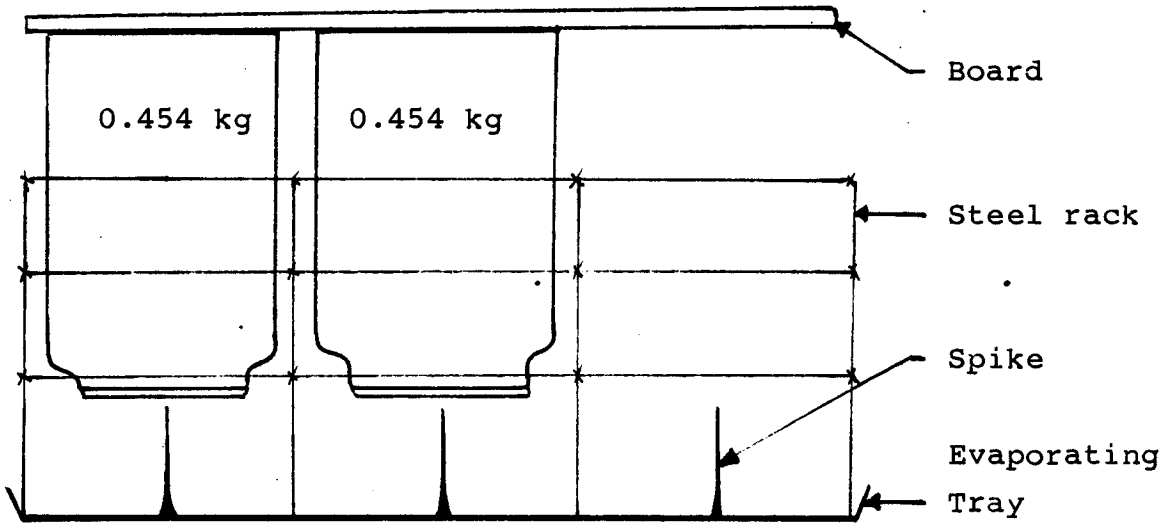
2. A welded steel rack with sharp spikes or nails welded upright to the bottom. The steel rack should have compartments large enough to hold a can of methyl bromide in an upright position. The entire steel rack should have a height less than the height of a 0.454 kg (1 lb) can of methyl bromide.

3. A board large enough to completely cover the steel rack.

4. Self-contained breathing apparatus or gas mask - full face piece (industrial) plus canister approved by U.S. Bureau of Mines and/or NIOSH for methyl bromide.

5. Halide leak detector or other suitable methyl bromide gas monitor.

6. Metal trays (not aluminum) to be used as evaporators.



7. One adult assistant.

8. Locks for the door or doors.

9. Signs - 35 cm high x 25 cm wide with red letters on a white background indicating a dangerous gas is being used inside.

10. Masking tape to seal leaks in tarps.

11. Fan(s) within greenhouse with outside switch control (40 cm fan per 1,400 m^3).

Procedure

Beds

1. A trench is made around the bed 20 cm to 25 cm deep.

2. The required number of cans of methyl bromide are inverted in the rack, so that the tops of the cans are touching the sharp points of the spikes and, when pressure is applied later, the can will be pierced. The rack supporting the cans should be placed on an evaporating tray located centrally on the bed. See dosage table ~~page 15~~ on label.

3. The board should be placed evenly over the cans. The tarp should be placed over the cans, steel rack and soil beds.

4. A 60 cm to 100 cm overlap of the tarp should be placed in the trench and the earth tamped in tightly. Make certain the tarp is taut over the bed allowing for good movement of the gas between the tarp and the bed. Similarly seal and secure the tarp at each end of the bed.

5. An approved sign - 35 cm high x 25 cm wide, indicating a dangerous gas is being used inside, should be posted at all entrances to the greenhouse. An approved gas mask or self-contained breathing apparatus should be worn by the exterminator and the assistant exterminator.

6. Before entering an atmosphere containing methyl bromide, be sure to check the mask for leaks. To do this, put

on the mask with the canister attached. Place a hand over the hole in the bottom of the canister and inhale. If perfectly tight, the face mask will collapse. Canister gas masks are only air purifying devices, it is therefore essential that they are used only in atmospheres which contain sufficient oxygen to support life (more than 16% at sea level) and which contain generally no more than 2% concentration of methyl bromide by volume. If the specific exposure concentrations are suspected of being in excess of this limit, a self-contained breathing apparatus should be used.

The operational life of a canister can vary from several minutes to an hour, depending on the design and/or the concentration to which it has been exposed. Once the canister becomes saturated with methyl bromide, it no longer protects the wearer.

A used canister should be broken and discarded for there is no sure way of determining the residual protection remaining in that canister.

7. A final check should be made to ensure that no humans or animals are in the greenhouse.

8. With the assistant standing at the door, the exterminator applies an even pressure on the tarp over the board in order to pierce the cans of methyl bromide and release the gas under the tarp.

9. The exterminator with his gas mask or self-contained breathing apparatus still on, accompanied by his assistant with his gas mask on, should take the halide leak detector and (1) test the edges for leaks, and (2) test the tarp itself for pin hole leaks. Any leaks must be sealed immediately. Leaks around edges may be sealed by tamping down the earth more efficiently. Leaks in the tarp may be sealed by covering with masking tape.

10. The exterminator and the assistant exterminator now leave the greenhouse and all the doors are locked. The keys to the doors are kept in the possession of the exterminator.

Flats

Same procedure as outlined above, however, the tarp is sealed to the floor by sand snakes or masking tape. Alternatively, a tarp could be laid down beneath the flats and the overlapping tarp sealed to it to create an air tight chamber. Asphalt floors will absorb methyl bromide readily, substantially reducing the fumigants purpose of insect control.

METHOD B

Alternate Method for Release of Methyl Bromide

Equipment Needed

1. Same as for Method A, except no steel rack or board.

2. Polyethylene tubing, 3 mm in diameter.

3. Stones, weights, etc. to be used to anchor one end of tubing in the evaporator trays.

4. Supports to keep the tarp suspended at least 15 cm above the soil surface. This could be 25 mm x 50 mm strapping supported by stakes placed horizontally down the middle of the bed or flats, or upended flower pots, crumpled fertilizer bags, racks filled with hay, etc.

5. A "Jiffy" applicator - may be obtained from your supplier of methyl bromide.

   The methyl bromide cans may be heated to between 18°C and 21°C, by immersing them in a bucket of warm water for several minutes.

Procedure

Beds

1. A trench is made around the bed 20 cm to 25 cm deep.

2. One edge of the tarp is placed in the trench and the earth tamped in tightly.

3. Supports are placed down the centre of the bed in order to keep the tarp suspended at least 15 cm above the soil.

4. Evaporating trays are placed in the middle of the bed.

5. Place pieces of 3 mm diameter plastic tubing of sufficient length to reach from each evaporating tray to

outside of the bed. Affix one end in the evaporating tray by means of the weight or stone.

6. Construct a similar trench 20 cm to 25 cm deep in the ground on the corridor side of the bed. Place the other edge of the tarp in this trench and tamp the earth down tightly. Make certain the tarp is taut over the bed, allowing for adequate movement of the gas between the tarp and the bed. The end of the 3 mm diameter plastic tubing should be easily accessible outside the tarp but with the earth well tamped around it to give a good seal. Seal and secure each end of the tarp.

7. An approved sign - 35 cm high x 25 cm wide, indicating a dangerous gas is being used inside, should be posted on all entrances to the greenhouse. An approved gas mask or self-contained breathing apparatus should be worn by the exterminator and the assistant exterminator. Both masks should be checked for leaks before entering the greenhouse.

8. A check should be made to ensure that no humans or animals are in the greenhouse.

9. You are now ready to release the gas. Take into consideration the need to maintain a sufficient temperature in the greenhouse. With the assistant exterminator standing at the door, the exterminator, by means of the "Jiffy" applicator will release the methyl bromide through each piece of tubing.

10. When all the gas has been released, either remove the tubing and seal this opening by tamping the earth above it or seal the end of the tube. The exterminator with his gas mask or self-contained breathing apparatus still accompanied by his assistant with his gas mask on should take the halide leak detector and (1) test the edges for leaks, especially where the tube was removed, and (2) test the tarp itself for pinhole leaks. Any leaks must be sealed immediately. Leaks around edges may be sealed by tamping down the earth more efficiently. Leaks in the tarp may be sealed by covering with masking tape.

Flats

Same procedure as outlined above, however, the tarp is sealed to the floor by sand snakes or masking tape. Alternatively, a tarp could be laid down beneath the flats and the overlapping tarp sealed to it to create an air tight chamber.

AERATION PROCEDURE

When commencing aeration, both exterminators should put on approved breathing apparatus. Open doors and windows from outside, if possible. Start ventilators and fans and leave the area again for 30 minutes. Then, with approved breathing apparatus on, enter the building to open doors and windows. Allow another 30 minutes to aerate. At the end of this period, gas detector tubes will then indicate areas requiring additional aeration.

No aeration can be carried out under inversion conditions. Inversions are most likely to occur during the summer from 1:00 a.m. to 8:00 a.m. During the winter, inversions are also likely to occur during early afternoon. Information on weather conditions can be obtained on a 24-hour basis for eastern Ontario by calling the Toronto Weather Office at (416) 676-3020 and for northwestern Ontario by calling the Winnipeg Weather Office at (204) 949-2071.